FORMIRANJE ARTERIOVENSKE FISTULE U AKSILARNOM BLOKU I SEDACIJI KOD DETETA SA TERMINALNOM BUBREŽNOM INSUFICIJENCIJOM – PRIKAZ SLUČAJA

PRIKAZ SLUČAJA

CASE REPORT

AXILLARY BRACHIAL PLEXUS BLOCK UNDER PROCEDURAL SEDATION FOR ARTERIOVENOUS FISTULA FORMATION IN A CHILD WITH END-STAGE RENAL DISEASE – A CASE REPORT

Lazar Jakšić[1], Emil Bosinci[1], Velja Milačić[2]

[1] Univerzitetska dečja klinika, Beograd, Srbija

[2] Institut za kardiovaskularne bolesti „Dedinje", Beograd, Srbija

[1] *University Children's Hospital, Belgrade, Serbia*

[2] *Institute for Cardiovascular Diseases Dedinje, Belgrade, Serbia*

SAŽETAK

Uvod/Cilj: Formiranje arteriovenske (AV) fistule predstavlja zlatni standard vaskularnog pristupa za hemodijalizu. Kod odraslih, primenom blokova brahijalnog pleksusa (BBP) za formiranje podlakatne AV fistule obezbeđujemo ne samo adekvatnu analgeziju već i pozitivno dejstvo na primarnu patentnost fistule. Takođe, usled ostvarenih uslova hirurške anestezije, intervenciju je moguće obaviti u uslovima proceduralne sedacije.

Prikaz slučaja: Pacijentkinja stara 12 godina primljena je zbog formiranja AV fistule radi izvođenja hemodijalize, a zbog terminalne bubrežne insuficijencije. Kifoskolioza torakalnog dela kičmenog stuba kao i kratak vrat ograničene pokretljivosti, te niski rast pacijentkinje, upućivali su na moguću otežanu intubaciju. Uprkos nedavno preležanoj infekciji gornjih disajnih puteva, koja je budila sumnju na njihovu pojačanu osetljivost, doneta je odluka o potrebi za hirurškim lečenjem. Odlučili smo se za aksilarni BBP u uslovima proceduralne sedacije. Primenjeno je osnovno praćenje vitalnih funkcija i data je kiseonička potpora od 3 l/min, putem maske. Blok je izveden pod kontrolom ultrazvuka, primenom 8 ml 0,5% levobupivakaina (1,4 mg/kg) i 5 ml 2% lidokaina (3,33 mg/kg). Tokom intervencije u trajanju od 100 minuta, pacijentkinja je bila u potpunosti hemodinamski i respiratorno stabilna, neometanog spontanog disanja. Buđenje je proteklo bez komplikacija, nakon čega je pacijentkinja upućena na odeljenje gde je analgezija održavana acetaminofenom, po potrebi. Ukupna perioperativna potrošnja opioida svedena je na uvodnu dozu fentanila od 0,83 μg/kg.

Zaključak: U ovom pedijatrijskom slučaju, aksilarni BBP obezbedio je adekvatnu analgeziju uz minimalnu upotrebu opioida prilikom formiranja AV fistule, kao i izbegavanje očekivane otežane intubacije. Neophodno je imati na umu maksimalne dozvoljene doze lokalnih anestetika, specifičnosti njihove primene kod dece sa komorbiditetima, kao i moguće komplikacije, među kojima je najznačajnija sistemska toksičnost lokalnih anestetika.

Ključne reči: anestezija, aksilarni blok brahijalnog pleksusa, pedijatrijski slučaj, hemodijaliza, terminalna bubrežna insuficijencija

ABSTRACT

Introduction/Objective: Arteriovenous (AV) fistula formation has become the gold standard for hemodialysis vascular access. The use of brachial plexus blocks (BPB) for antebrachial AV fistula formation in adults provides not just adequate analgesia but a potentially positive effect on primary fistula patency. Additionally, the resultant state of surgical anesthesia may enable the surgery to be performed under procedural sedation.

Case report: A 12-year-old patient was admitted for AV fistula formation for the purpose of hemodialysis due to end-stage renal disease. Kyphoscoliosis of the thoracic spine, the patient's short neck with limited mobility, and her short stature posed a potential difficulty for intubation. Despite a recently resolved upper respiratory tract infection, which raised suspicion of airway hyperreactivity, the decision was made to proceed with surgical treatment and perform an axillary BPB under procedural sedation. Basic monitoring of vital functions was applied, with oxygen support at 3 l/min via mask. The ultrasound-guided block was performed using 8 ml of 0.5% levobupivacaine (1.4 mg/kg) and 5 ml of 2% lidocaine (3.33 mg/kg). During the one-hundred-minute surgical procedure, the patient maintained hemodynamic and respiratory stability and spontaneous breathing. The patient awoke without complications and was referred to the hospital ward. Her pain was managed with acetaminophen, as needed. The total perioperative opioid consumption was limited to the induction dose of 0.83 μg/kg of fentanyl.

Conclusion: In this pediatric case, the use of axillary BPB provided adequate analgesia with minimal opioid administration for the formation of an AV fistula. It also enabled the surgical team to avoid an expectedly difficult intubation. One needs to keep in mind the maximum safe dose of local anesthetics, the nuances of their use in children with comorbidities, as well as the potential complications, among which local anesthetic systemic toxicity is the most important.

Keywords: anesthesia, axillary brachial plexus block, pediatric case, hemodialysis, end-stage renal disease

Autor za korespondenciju:
Lazar Jakšić
Univerzitetska dečja klinika
Tiršova 10, 11000 Beograd, Srbija
Elektronska adresa: lazar.jaksic@udk.bg.ac.rs

Corresponding author:
Lazar Jakšić
University Children's Hospital
10 Tiršova Street, 11000 Belgrade, Serbia
E-mail: lazar.jaksic@udk.bg.ac.rs

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UVOD

Vaskularni pristup za hemodijalizu moguće je ostvariti formiranjem arteriovenske fistule ili grafta, plasiranjem venskog ili intraperitonealnog katetera. Zbog niže stope infekcije i tromboze, kao i boljeg protoka krvi, formiranje arteriovenske (AV) fistule predstavlja zlatni standard vaskularnog pristupa za dijalizu kod odraslih pacijenata [1], pri čemu je dobrobit navedene metode prepoznata i u pedijatrijskoj populaciji [2,3]. Kod odraslih pacijenata, jasno je opisan pozitivan efekat vazodilatacije izazvane blokom brahijalnog pleksusa (BBP) na primarnu patentnost podlakatne AV fistule [4–6]. Kod dece, isti efekat nije do sada ispitivan, te samo može biti pretpostavljen. Iako je aksilarni BBP prethodno primenjivan kod određenih pedijatrijskih pacijenata u kombinaciji sa opštom anestezijom, slučajevi izvođenja intervencije u uslovima bloka i proceduralne sedacije nisu opisani. Kako BBP, a konkretno aksilarni BBP, obezbeđuje hiruršku anesteziju za intervencije ispod nivoa lakta [7], pacijenti pod povišenim rizikom od komplikacija izazvanih endotrahealnom intubacijom (mehaničke povrede, bronhospazam, nemogućnost intubacije, i dr.) i opštom anestezijom mogli bi da budu kandidati za izvođenje intervencije u uslovima regionalne anestezije. Izvođenje aksilarnog bloka brahijalnog pleksusa takođe može biti praćeno komplikacijama, kao što su neuspeli blok, oštećenje nerava, akcidentalna intravaskularna primena lokalnog anestetika i sledstvena sistemska toksičnost.

PRIKAZ SLUČAJA

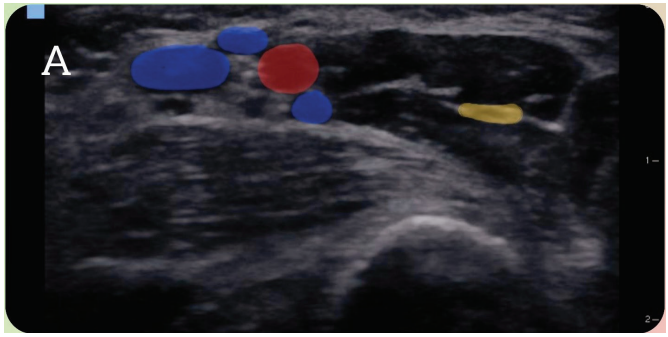
Devojčica stara 12 godina, visoka 110 cm i teška 36 kg, primljena je na Odeljenje nefrologije Univerzitetske dečje klinike, radi formiranja podlakatne arteriovenske fistule. Prethodno je podvrgnuta operativnom lečenju mijelomeningocele. Takođe je praćena zbog dobro kontrolisane epilepsije, hipotireoze, anemije, i arterijske hipertenzije. Klasifikovana je kao ASA (engl. *American Society of Anesthesiology*) status 3. Pacijentkinji je preoperativno bio ograničen unos hrane i vode, bez anamnestičkih podataka ili kliničkih pokazatelja povraćanja. Usled renalne osteodistrofije, pacijentkinja je imala značajnu kifoskoliozu torakalnog dela kičmenog stuba, kao i nizak rast, a uočena je i umereno ograničena pokretljivost vrata u svim pravcima. Ordinirajući anesteziolog procenio je da bi endotrahealna intubacija mogla biti otežana. Uz Mekintoš i Miler špatule različitih veličina za direktnu laringoskopiju, na raspolaganju nam je bio i fiberoptički bronhoskop. Dodatni faktor rizika predstavljala je infekcija gornjih disajnih puteva preležana dve nedelje pred intervenciju. Uprkos sledstveno povećanom riziku od pojave

INTRODUCTION

Vascular access for hemodialysis can be established by forming an arteriovenous fistula or graft, or by placing a venous or intraperitoneal catheter. Due to lower rates of infection and thrombosis, as well as better blood flow, formation of an arteriovenous (AV) fistula is the gold standard for hemodialysis vascular access in adult patients [1], with the benefits of this method also recognized in the pediatric population [2,3]. In adults, the positive effect of vasodilation induced by brachial plexus block (BPB) on the primary patency of forearm AV fistulas has been clearly described [4–6]. In children, this effect has not yet been investigated and can only be hypothesized. Although axillary BPB has previously been applied in certain pediatric patients in combination with general anesthesia, cases of performing the procedure under regional block and procedural sedation have not as yet been reported. As BPB, and more specifically axillary BPB, provides surgical anesthesia for procedures below the level of the elbow [7], patients at increased risk of complications associated with endotracheal intubation (mechanical injury, bronchospasm, failed intubation, etc.) and general anesthesia may be candidates for undergoing the procedure under regional anesthesia. However, an axillary brachial plexus block may also be associated with complications, such as block failure, nerve injury, accidental intravascular administration of local anesthetic, and consequent systemic toxicity.

CASE REPORT

A 12-year-old girl, 110 cm in height and weighing 36 kg, was admitted to the University Children's Hospital Department of Nephrology for the formation of a forearm arteriovenous fistula. She had previously undergone surgical treatment for myelomeningocele. She was also being monitored for well-controlled epilepsy, hypothyroidism, anemia, and arterial hypertension. She was classified as American Society of Anesthesiologists (ASA) physical status III. Preoperatively, oral intake of food and fluids was restricted, with no anamnestic data or clinical signs of vomiting. Due to renal osteodystrophy, the patient had marked thoracic kyphoscoliosis, as well as short stature, and moderately limited neck mobility in all directions was also observed. The attending anesthesiologist assessed that endotracheal intubation might prove difficult. In addition to Macintosh and Miller laryngoscope blades of various sizes for direct laryngoscopy, a fiberoptic bronchoscope was also available. An additional risk factor was an upper respiratory tract infection that had resolved two weeks prior to the procedure. Despite the consequently increased risk of complications associated with endotra-



Slika 1.
A. Aksilarna arterija (crveno), aksilarne vene (plavo), mišićno-kožni živac (žuto).
B. Aksilarna arterija (crveno), aksilarne vene (plavo), lokalni anestetik (zeleno), igla (žuta strelica).

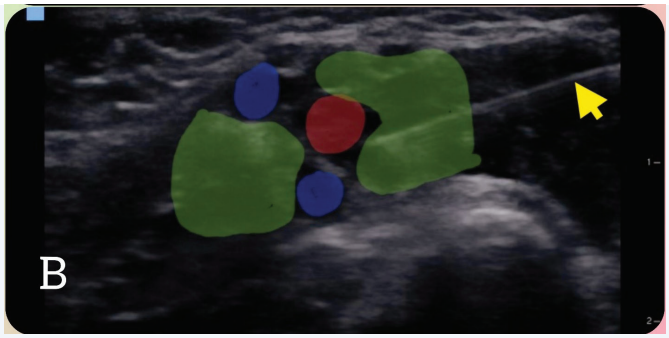


Figure 1.
A. Axillary artery (red), axillary veins (blue), musculocutaneous nerve (yellow).
B. Axillary artery (red), axillary veins (blue), local anesthetic (green), needle (yellow arrow)

komplikacija izazvanih endotrahealnom intubacijom, zbog progresije primarne bolesti doneta je odluka o operativnom lečenju.

Odlučeno je da su u uslovima proceduralne sedacije izvede aksilarni BBP. Neposredno pre uvođenja u anesteziju, izmeren je neinvazivni krvni pritisak od 125/87 mmHg. Pri uvođenju u anesteziju, pacijentkinji je venskim putem dato 1 mg midazolama i 30 µg fentanila, a sedacija je održavana infuzijom propofola u dozi od 6–8 mg/kg/h. Aksilarni BBP (Slika 1) izveden je u uslovima asepse pod kontrolom ultrazvuka (aparat *eZono 4000*, igla veličine 22G/50mm, *in-plane* tehnika). Oko nerava samog pleksusa dato je 8 ml 0,5% levobupivakaina i 5 ml 2% lidokaina, dok je oko mišićno-kožnog živca čije grane inervišu kožu spoljašnje strane podlaktice dat po 1 ml navedenih lokalnih anestetika. Ukupno je dato 1,4 mg/kg levobupivakaina i 3,33 mg/kg lidokaina. Primenjeno je osnovno praćenje vitalnih funkcija.

Tokom intervencije, pacijentkinja je bila u potpunosti hemodinamski i respiratorno stabilna uz kiseoničku potporu od 3 l/min, putem maske, sa vrednostima srednjeg arterijskog pritiska između 85 i 90 mmHg.

Buđenje je proteklo bez komplikacija koje bi zahtevale intervenciju, odmah nakon čega je pacijentkinja prevedena na odeljenje. Postoperativna analgezija bila je zadovoljavajuća, uz uvođenje 500 mg intravenskog acetaminofena tek 8 sati nakon intervencije. Postoperativni bol praćen je uz pomoć NRS skale (engl. *Numeric Rating Scale*), a ponavljane doze analgetika davane su u slučaju prijavljenog intenziteta bola od tri ili više. Ukupna doza acetaminofena u prvom postoperativnom danu iznosila je 1 g. Kako opioidi nisu davani postoperativno, ukupna primena opioida svela se na uvodnu dozu fentanila od 0,83 µg/kg. U postoperativnom toku nisu uočene komplikacije po tipu oštećenja nerava, infekcije ubodnog mesta, kao ni toksičnih efekata lokalnih anestetika.

cheal intubation, surgical treatment was indicated due to progression of the primary disease.

It was decided to perform an axillary BPB under procedural sedation. Immediately prior to induction of anesthesia, noninvasive blood pressure was registered at 125/87 mmHg. At induction, the patient received 1 mg of midazolam and 30 µg of fentanyl intravenously, and sedation was maintained with a propofol infusion at a dose of 6–8 mg/kg/h. The axillary BPB (Figure 1) was performed under aseptic conditions with ultrasound guidance (eZono 4000 device, 22G/50 mm needle, in-plane technique). A total of 8 ml of 0.5% levobupivacaine and 5 ml of 2% lidocaine was administered around the nerves of the plexus, while 1 mL of each of the aforementioned local anesthetics was administered around the musculocutaneous nerve, whose branches innervate the skin of the lateral forearm. The total administered doses were 1.4 mg/kg of levobupivacaine and 3.33 mg/kg of lidocaine. Standard monitoring of vital signs was applied.

During the procedure, the patient remained completely hemodynamically and respiratorily stable, with oxygen support at 3 l/min via face mask and with mean arterial pressure readings between 85 and 90 mmHg.

Emergence from anesthesia was uneventful and without complications requiring intervention, upon which the patient was transferred to the hospital ward. Postoperative analgesia was satisfactory, and 500 mg of intravenous acetaminophen was administered only after eight hours since the procedure had passed. Postoperative pain was monitored using the Numeric Rating Scale (NRS), and repeated doses of analgesics were administered in cases of reported pain intensity of three or higher. The total dose of acetaminophen during the first postoperative day was 1 g. As no opioids were administered postoperatively, total opioid use was limited to the induction dose of fentanyl (0.83 µg/kg). No postoperative complications were observed, including nerve injury, puncture-site infection, or toxic effects of local anesthetics.

DISKUSIJA

Formiranje pouzdanog i dugotrajnog vaskularnog pristupa za dijalizu kod pedijatrijskih pacijenata sa terminalnom bubrežnom insuficijencijom je od ključnog značaja. Iako postoje alternativna rešenja, kao što su venski i peritonealni kateteri, formiranje AV fistule predstavlja zlatni standard [1]. Prethodno su takvi pacijenti podvrgavani isključivo opštoj anesteziji, pri čemu je učinjen pomak ka primeni različitih metoda regionalne anestezije u odrasloj populaciji [4–6]. Inicijalno je primenjivana infiltracija lokalnim anestetikom, međutim blokovi brahijalnog pleksusa su se, zbog obezbeđivanja uslova hirurške anestezije, nametnuli kao primarno rešenje za podlakatne fistule [7]. Kod odraslih pacijenata, formiranje fistule uz BBP uveliko se sprovodi u budnom stanju ili u uslovima sedacije, dok kod dece to još uvek nije slučaj, te se i dalje mahom sprovodi u obaveznoj opštoj anesteziji. Primena perifernih nervnih blokova u budnom stanju, procedu-ralnoj sedaciji ili u opštoj anesteziji kod dece nije povezana sa povišenom incidencijom komplikacija [8]. Tome doprinosi činjenica da je kod pacijenata koji se podvrgavaju elektivnim intervencijama neophodno potvrditi striktno poštovanje preoperativnog ograničenja unosa na usta, te jasno utvrditi faktore koji bi mogli doprineti regurgitaciji i sledstvenoj aspiraciji želudačnog sadržaja (npr. gastroezofagealni refluks, nedavno povraćanje bilo koje prirode, emetogene hirurške intervencije, primena emetogenih lekova) [9].

Adekvatna kontrola bola u postoperativnom periodu je od izuzetnog značaja i može da spreči prenaglašene odgovore na bol u starijem uzrastu [10]. Kako bi to bilo ostvareno, uz što manju upotrebu opioida, periferni nervni blokovi su predloženi kao jedan od efektivnih modaliteta [11]. Dobrobit primene ovog bloka takođe je uočena kada je u pitanju primarna patentnost fistule. Naime, kod odraslih pacijenata su opisani bolji i dugotrajniji rezultati po pitanju patentnosti fistule u odnosu na pacijente koji nisu dobili blok [4,5].

U pedijatrijskoj populaciji taj efekat nije do sada ispitivan, te samo može biti pretpostavljen. Nažalost, BBP se i dalje ne primenjuju rutinski kod dece podvrgnute formiranju podlakatne AV fistule. Deca su kao populacija sklonija otežanoj intubaciji i hiperreaktivnosti disajnog puta, što kod njih dovodi do učestalije pojave respiratornih komplikacija, kao što su laringospazam i bronhospazam, naročito kada istovremeno postoje faktori koji doprinose navedenoj hiperreaktivnosti [12–14]. Pacijenti prepoznati kao visokorizični bi mogli biti podvrgnuti formiranju fistule u uslovima sedacije i aksilarnog bloka brahijalnog pleksusa, te na taj način pošteđeni mogućih komplikacija izazvanih endotrahealnom intubacijom. Dobra klinička praksa nalaže da

DISCUSSION

Establishing reliable and long-lasting vascular access for dialysis in pediatric patients with end-stage renal disease is of critical importance. Although alternative options exist, such as venous and peritoneal catheters, AV fistula formation remains the gold standard [1]. Historically, such patients have been managed exclusively under general anesthesia. However, there has been a shift towards the use of various regional anesthesia techniques in the adult population [4–6]. Initially, local anesthetic infiltration was used. However, brachial plexus blocks have emerged as the primary modality for forearm fistula formation due to their ability to provide surgical anesthesia [7]. In adults, fistula formation under BPB is widely performed in awake patients or under sedation, whereas in children, this is still not the case, and procedures are predominantly performed under mandatory general anesthesia. In children, the use of peripheral nerve blocks in awake patients, patients under procedural sedation, or under general anesthesia has not been associated with an increased incidence of complications [8]. This is supported by the requirement that patients undergoing elective procedures must demonstrate strict adherence to preoperative fasting guidelines, and that factors possibly contributing to regurgitation and subsequent aspiration of gastric contents (e.g., gastroesophageal reflux, recent vomiting of any etiology, emetogenic surgical procedures, administration of emetogenic drugs) must be clearly identified [9].

Adequate postoperative pain control is of paramount importance and may prevent exaggerated pain responses later in life [10]. To achieve this while minimizing opioid use, peripheral nerve blocks have been proposed as an effective modality [11]. The benefit of this block has also been observed in terms of primary fistula patency. Specifically, in adult patients, better and more durable fistula patency outcomes have been reported compared with patients who did not receive a block [4,5].

In the pediatric population, this effect has not yet been investigated and can only be hypothesized. Unfortunately, BPBs are still not routinely used in children undergoing forearm AV fistula formation. Children, as a population, are more prone to difficult intubation and airway hyperreactivity, which leads to a higher incidence of respiratory complications such as laryngospasm and bronchospasm, particularly in the presence of concomitant risk factors that contribute to such hyperreactivity [12–14]. Patients identified as high risk could undergo fistula formation under sedation combined with an axillary brachial plexus block, thereby avoiding potential complications associated with endotracheal intubation. Good clinical practice dictates

je u ovakvim slučajevima i dalje neophodno biti u pripravnosti za hitnu intubaciju kao i za zbrinjavanje eventualno nastalog laringospazma i/ili bronhospazma.

Kombinovana primena kratkodelujućih i dugodelujućih lokalnih anestetika je i dalje predmet rasprave [15,16]. Kliničko iskustvo naše ustanove podudarno je sa istraživanjima koja upućuju na brže ostvarene uslove hirurške anestezije [17]. Takođe, nije jasno dokazano da kombinovana primena lokalnih anestetika neće dovesti do bržeg nastanka hirurške anestezije od izolovane primene dugodelujućih lokalnih anestetika [18].

Iako terminalna bubrežna insuficijencija nema značajniji uticaj na farmakokinetiku amidnih lokalnih anestetika [19,20], neophodno je preduzeti mere predostrožnosti po pitanju komplikacija izazvanih primenom lokalnih anestetika, a prevashodno po pitanju njihove sistemske toksičnosti. Sistemska toksičnost lokalnih anestetika (engl. *local anesthetic systemic toxicity – LAST*) predstavlja retku i najtežu sistemsku komplikaciju u regionalnoj anesteziji. Nastaje kao rezultat osnovnog mehanizma dejstva lokalnih anestetika, odnosno blokade natrijumskih kanala. Zbog gotovo univerzalnog prisustva natrijumskih kanala u tkivima, klinička slika je izuzetno varijabilna (trnjenje usana, osećaj metalnog ukusa u ustima, zujanje u ušima, vrtoglavica, arterijska hipertenzija ili hipotenzija, tahikardični ili bradikardični poremećaji srčanog ritma do asistolije, konvulzije, poremećaji stanja svesti do kome) i zavisi od količine leka koja je dospela u krvotok, kao i od organskog sistema koji je dominantno zahvaćen [21].

U prikazanom pedijatrijskom slučaju, primena aksilarnog bloka brahijalnog pleksusa obezbedila je adekvatnu intraoperativnu analgeziju i smanjila perioperativnu potrošnju opioida prilikom formiranja podlakatne AV fistule. Ovakav pristup pružio je uslove za izvođenje intervencije u uslovima proceduralne sedacije, čime je izbegnuta očekivana otežana intubacija, kao i potencijalne komplikacije izazvane takvom intubacijom. U eventualnoj rutinskoj primeni, neophodno je imati na umu maksimalne dozvoljene doze lokalnih anestetika, specifičnosti njihove primene kod dece sa komorbiditetima, kao i moguće komplikacije, među kojima je najznačajnija sistemska toksičnost lokalnih anestetika.

Sukob interesa: Nije prijavljen.

that, even in such cases, preparedness for emergency intubation and management of potential laryngospasm and/or bronchospasm remains essential.

The combined use of short-acting and long-acting local anesthetics remains a subject of debate [15,16]. The clinical experience in our hospital is consistent with studies suggesting more rapid achievement of surgical anesthesia conditions [17]. However, it has not been clearly demonstrated that combined administration of local anesthetics will not result in a faster onset of surgical anesthesia compared with the use of long-acting local anesthetics alone [18].

Although end-stage renal disease does not significantly affect the pharmacokinetics of amide local anesthetics [19,20], precautionary measures regarding complications associated with their use are necessary, particularly with respect to systemic toxicity. Local anesthetic systemic toxicity (LAST) is rare but is also the most severe systemic complication in regional anesthesia. It results from the primary mechanism of local anesthetics action, namely, sodium channel blockade. Given the near-universal presence of sodium channels in tissues, the clinical presentation is highly variable (perioral numbness, metallic taste, tinnitus, dizziness, arterial hypertension or hypotension, tachyarrhythmia or bradyarrhythmia, which may escalate to asystole, seizures, altered consciousness, which may escalate to a coma) and depends on the amount of drug that has entered the circulation, as well as the organ system predominantly affected [21].

In the presented pediatric case, the use of an axillary brachial plexus block provided adequate intraoperative analgesia and reduced perioperative opioid consumption during the formation of a forearm AV fistula. This approach enabled the procedure to be performed under procedural sedation, thereby avoiding anticipated difficult intubation and potential complications associated with it. In potential routine application, it is essential to consider the maximum allowable doses of local anesthetics, the specifics of their use in children with comorbidities, as well as possible complications, among which local anesthetic systemic toxicity is the most significant.

Conflict of interest: None declared.

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